Vehicle compliance and enforcement after discovery of Volkswagen's defeat device
大众失效装置事件后的机动车达标管理与执行

Drew Kodjak, Executive Director
国际清洁交通委员会执行董事

The 5th Sino-US Mobile Source Emission Control Workshop
第五届中美机动车排放达标监管研讨会
Beijing China 中国北京
October 2015

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

I have created about 20 slides, and I've given myself about 40 minutes to run through them
My purpose is to set the tone and historical touchstones for the two days that we will spend together.

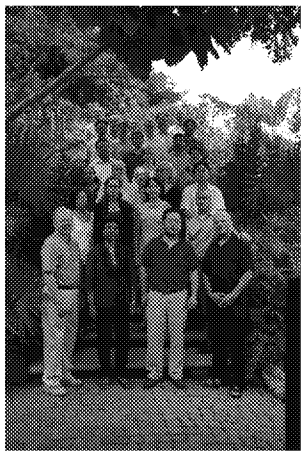
ICCT mission and activities
ICCT目标和简介

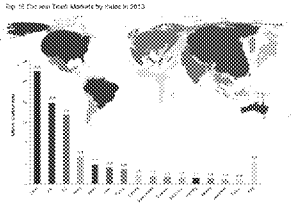
The mission of ICCT is to dramatically improve the environmental performance and efficiency of cars, trucks, buses and transportation systems in order to protect and improve public health, the environment, and quality of life.

- Non-profit research organization
- Air Pollution and Climate Impacts
- Focus on regulatory policies and fiscal incentives
- Activity across modes including aviation and marine
- Global outreach, with special focus on largest markets

国际清洁交通委员会(ICCT)宗旨是改善包括轻、重型车、航空和船舶等所有交通部门及整个交通系统的能效和环境影响，从而促进人类健康。

- 非盈利独立研究组织
- 着眼于空气污染和气候变化影响
- 研究主要针对标准法规政策、辅助性政策
- 研究方向覆盖所有交通部门
- 项目涉及全球主要汽车市场、全球性视角





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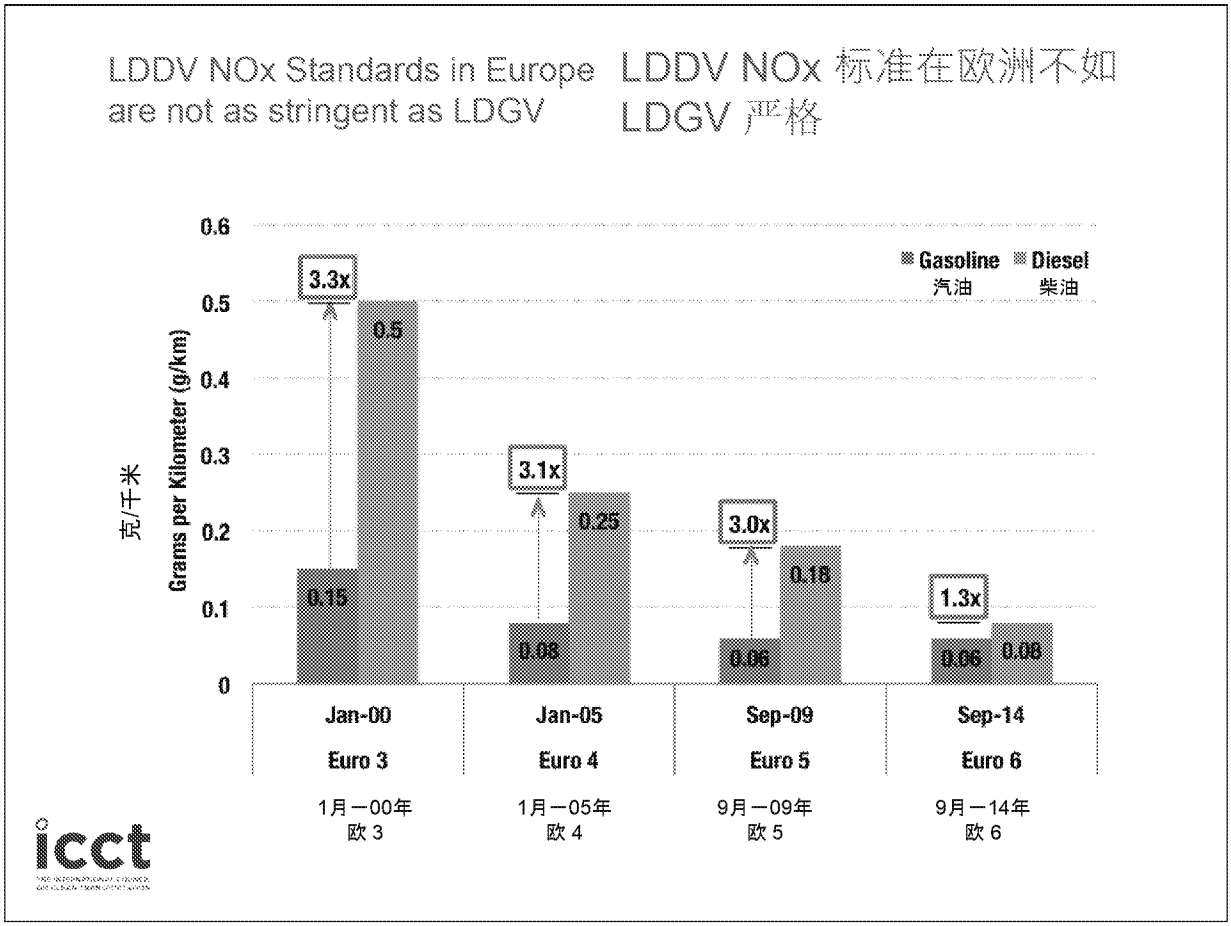
Timeline of Volkswagen Defeat Device Investigation and Discovery

- **2012** – ICCT's European office concerned with elevated real world NOx emissions from passenger diesels in Europe.
- **2013** – ICCT contracts with West Virginia University to conduct real world emissions testing on three passenger diesel vehicles in California. CARB provides in-kind support via its test center in El Monte.
- **May 2014** – ICCT publishes its findings which show two of the three cars with 5 – 35X times the legal limit under normal driving conditions. We inform EPA, CARB, and VW.
- **December 2014** – VW agrees to a voluntary recall of passenger diesels.
- **May 2015** – CARB retests recalled vehicles and finds some improvement, but not enough.
- **July-September 2015** – US EPA informs VW that it will not be granted license to sell 2016 vehicles in the US if the Agency's questions are not addressed fully. VW admits to defeat devices on September 3, 2015.
- **September 18, 2015** – US EPA, DOJ, and CARB announce a notice of violation against VW for using illegal defeat devices.
- **September 22, 2015** – VW announces that 11 million diesel cars worldwide have the same "defeat device" software.
- **September 25, 2015** – US EPA and CARB issue updated requirements related to evaluation of defeat devices

大众失效装置调查和发现的时间轴

- **2012** – ICCT 的欧洲办事处关注欧洲乘用车实际的高 NOx 排放
- **2013** – ICCT 与西弗吉尼亚大学签订合同，在加州对三辆乘用柴油车进行现实世界排放测试。CARB 通过他们在 El Monte 的实验室提供实物支持。
- **5月 2014** – ICCT 公布了调查结果，显示三辆车中有两辆在正常驾驶条件下排放是法定上限的5 – 35X 倍。我们通知了EPA, CARB, 和 VW。
- **12月 2014** – VW 同意自愿召回乘用柴油车。
- **5月 2015** – CARB 重新检测召回的车辆并发现了一些改进，但并不足够。
- **7-9月 2015** – US EPA 通知 VW，如果他们不充分回答问题，EPA 将不会给他们颁发销售2016年汽车所必需的认证证书。VW 在2015年9月3日承认了失效装置的存在。
- **9月 18日, 2015** – US EPA, DOJ 和 CARB发表了对于VW使用违法失效装置的通知。
- **9月 22日, 2015** – VW 声明全球有1100万乘用柴油车装有该‘失效装置’软件。
- **9月 25日, 2015** – US EPA 和 CARB 发表对于失效装置评估的更新要求。



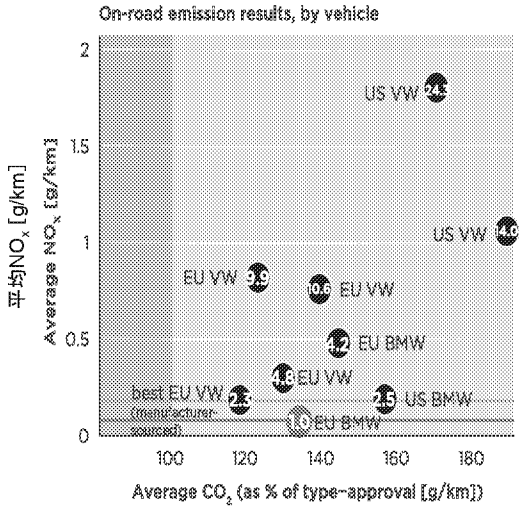
Again, I don't know if you want to include this in the presentation or not. The point here is that its not just that diesels are grossly exceeding the NOx standards in-use – they aren't even meeting less stringent NOx standards.

ICCT's Diesel emissions meta-study

ICCT 轻型柴油车排放研究

On-road Euro 6 conformity factors for selected cars (US factors would be 2x)

道路欧6部分车辆的达标因子 （美国的因子为2倍）



Above type-approval
Below or equal to type-approval
Above Euro 5 limit
Above Euro 6, below Euro 5 limit
Below Euro 6 limit
Euro 5 limit
Euro 6 limit

高于型号认证
等于或低于型号认证
高于欧5
高于欧6，小于欧5
低于欧6
欧5
欧6

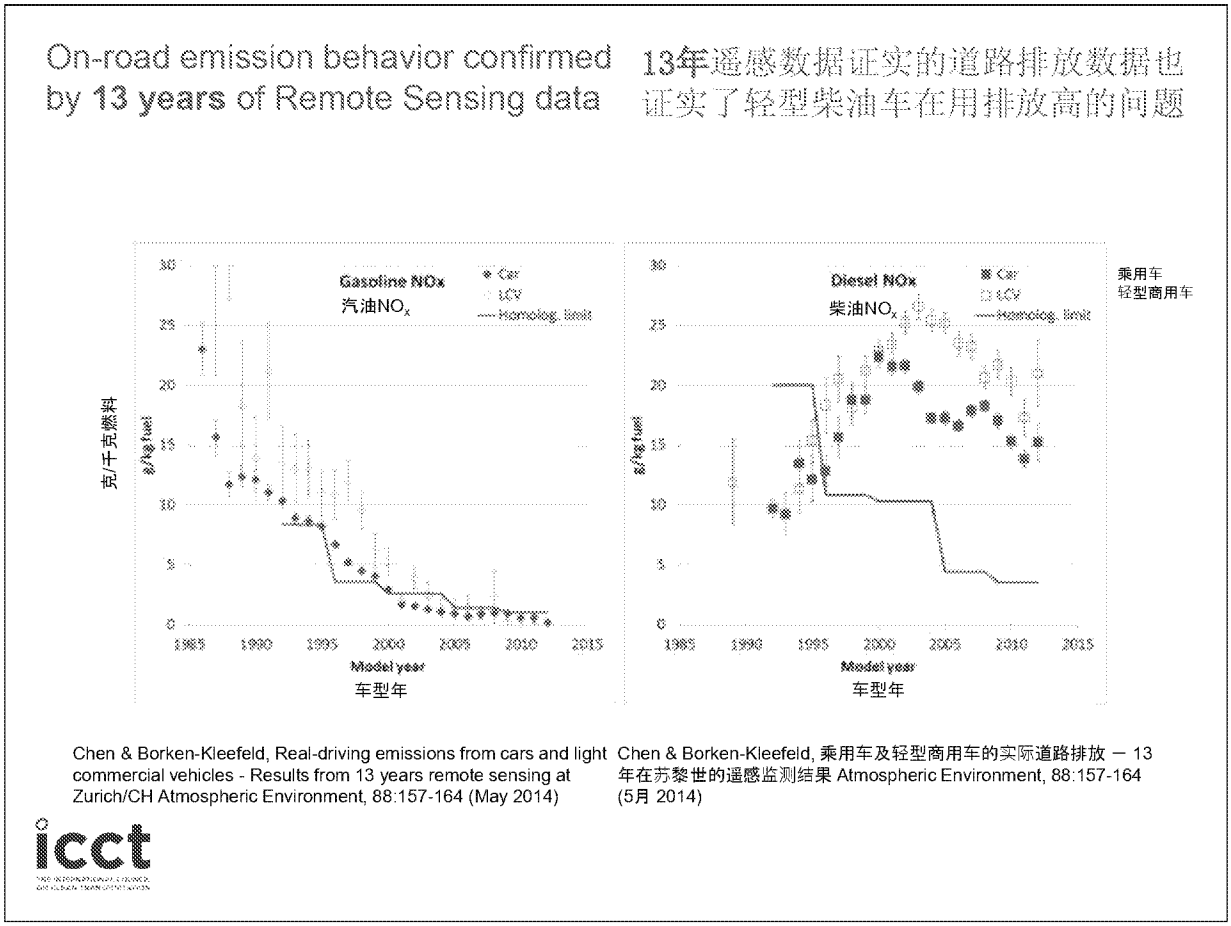
15 test vehicles in total (6 manufacturers), with different NO_x control technologies:
- 10 selective catalytic reduction (SCR)
- 4 exhaust gas recirculation (EGR)
- 1 lean NO_x trap (LNT)

Average Euro 6 NO_x conformity factors (ratio of on-road emissions to legal limits):
- all cars: 7.1
- best performer (Vehicle C, SCR): 1.0
- bad performer (Vehicle H, LNT): 24.3
- worst performer (Vehicle L, SCR): 25.4

15个测试车辆（6家生产商）有不同的NOx控制技术：
- 10 选择性催化还原 （SCR）
- 4 废气再循环 （EGR）
- 1 NOx 吸附 （LNT）

欧6平均达标因子（道路排放与法定上限之比）：
- 所有车辆：7.1
- 最好(C, SCR)：1.0
- 较差(H, LNT)：24.3
- 最差(L, SCR)：25.4

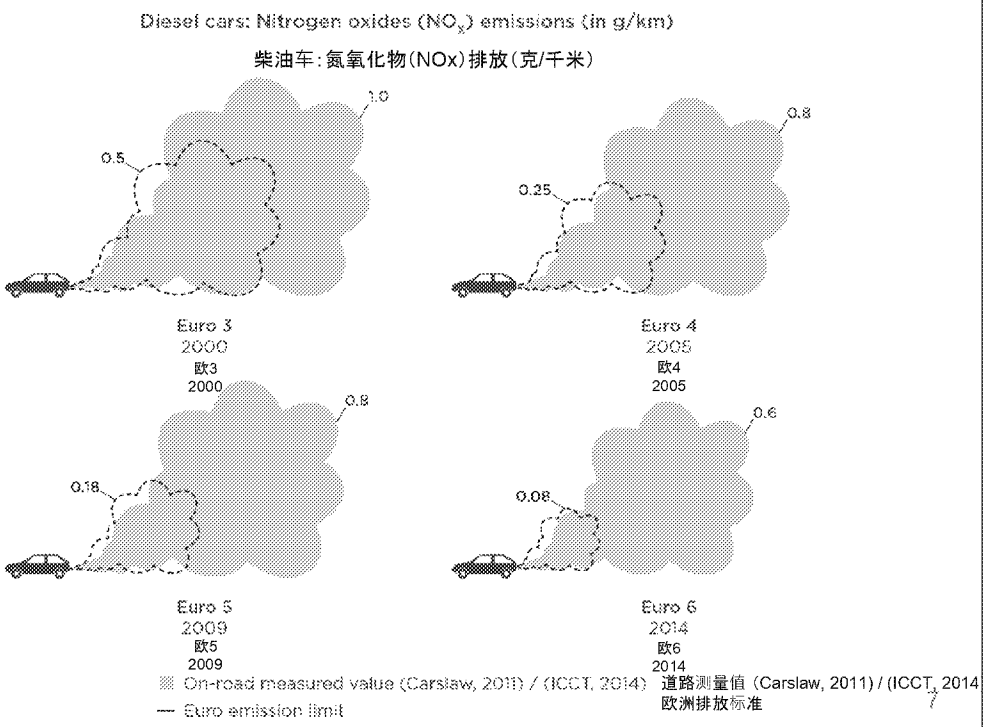
http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars



We report on long-term remote sensing measurements of light duty vehicle emissions at one site close to Zurich/Switzerland. The time series of annual measurements at the same site between 2000 and 2012, the same season, and virtually the same instrument is unique, probably worldwide. We analyze the development of unit exhaust emissions from model years 1985 until 2012, covering all five Euro emission limit stages in force. NOx emissions from both diesel cars and light commercial vehicles have actually increased in real-driving over time although emission limits have been progressively tightened. This behavior is explained mostly by a significant discrepancy between engine conditions during real-driving and the homologation test procedure. This discrepancy is not important for the other pollutants or for gasoline light duty vehicles, for which the emission control equipment is found working over a wide range of engine conditions. Our results confirm emission factors from the latest HBEFA model when deterioration and engine load are accounted for.

Real-world NO_X: Euro 6 Diesel cars are (on average) worse than they should have been 15 years ago

NO_X实际排放：欧6柴油车（平均水平）比他们15年前应该达到的水平还糟糕



From laboratory to road: PEMS makes it possible to accurately measure real-world emissions

从实验室到道路上：PEMS使得精细测量实际排放成为可能

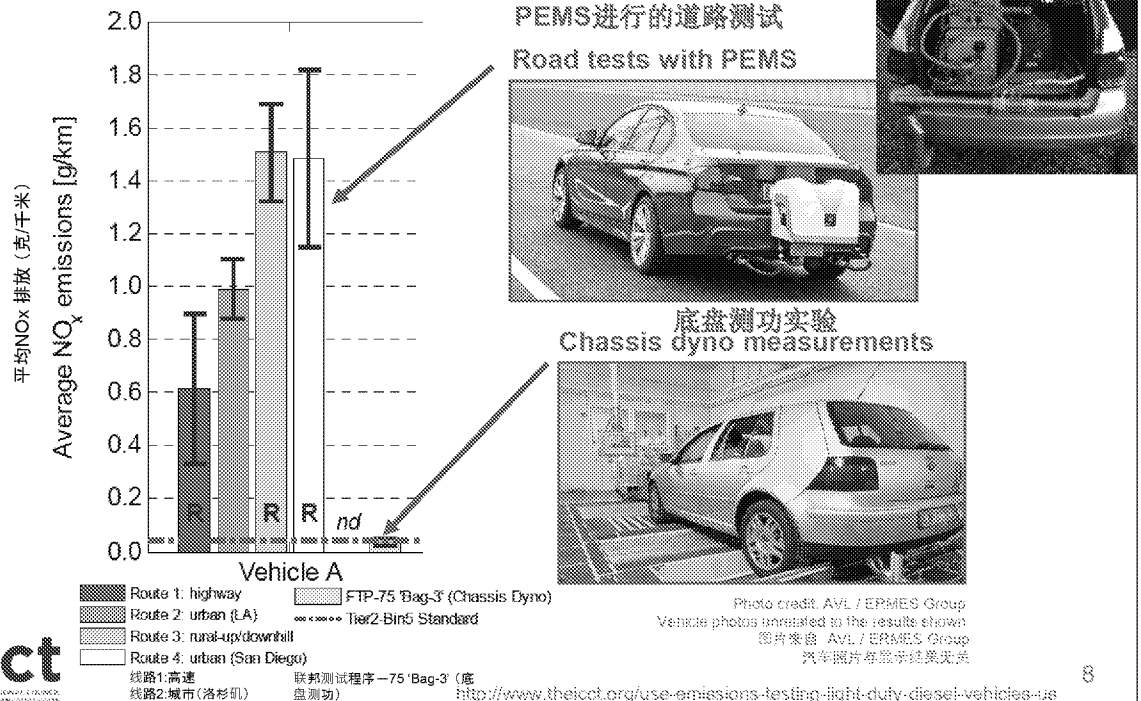


Photo credit: AVL / EPMES Group
Vehicle photos unrelated to the results shown
图片来自 AVL / EPMES Group
汽车图片与显示结果无关

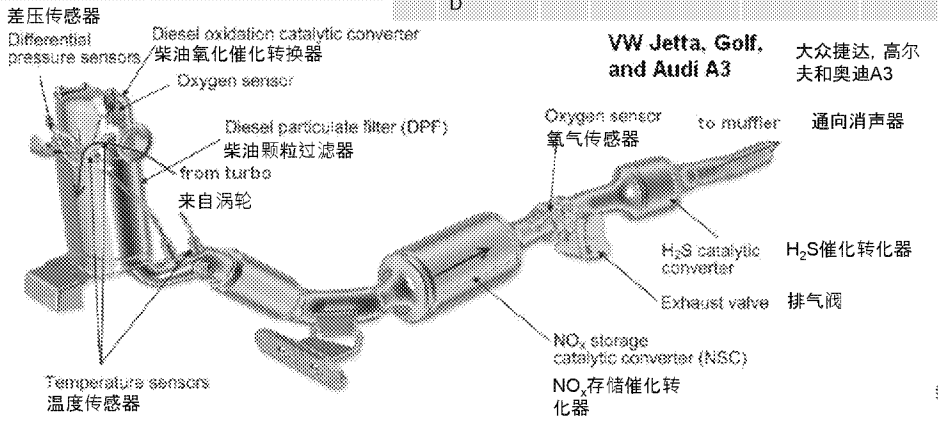
http://www.theicct.org/use-emissions-testing-light-duty-diesel-vehicles-us

ICCT PEMS Testing: Test Vehicles

ICCT PEMS 测试：测试车辆

No	Make	MY	Engine	Mileage	Aftertreatment	Emissions Limit
1	**VW Jetta Wagon TDI**	2012	2.0L	4710	**DOC+DPF + LNT**	Tier 2 Bin 5/ ULEV II
2	VW Passat TDI	2012	2.0L	15226	DOC+DPF + SCR	Tier 2 Bin 5/ ULEV II
3	BMW X5 xDrive35D	2012	3.0L V6	15000	DOC+ DPF + SCR	Tier 2 Bin 5/ ULEV II

号码	车型	年型年	发动机	里程	后处理装置	排放标准
1	**大众捷达旅行车 TDI**	2012	2.0L	4710	**氧化催化+颗粒过滤+NO_x吸附**	Tier 2 Bin 5/ ULEV II
2	大众帕萨特 TDI	2012	2.0L	15226	氧化催化+颗粒过滤+选择性催化还原	Tier 2 Bin 5/ ULEV II
3	宝马 X5 xDrive35D	2012	3.0L V6	15000	同上	Tier 2 Bin 5/ ULEV II



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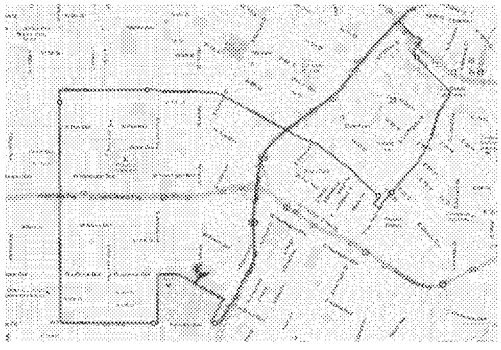
This is an internal presentation. Vehicle makes will be hidden for RDE presentations.

PEMS Testing Routes　PEMS 测试路线

Route 1 – Highway (Los Angeles to Ontario, CA)
线路 1 – 高速（洛杉矶到安大略，加州）

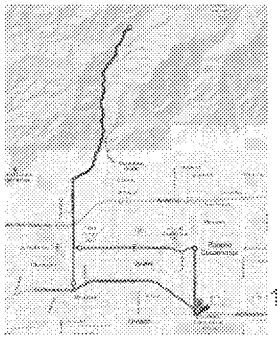
Route 2 – Urban (Los Angeles) – similar to original route used for development of the LA-4 / FTP-72
线路2 – 城市（洛杉矶）－类似原来用于研发LA-4 / FTP-72的路线



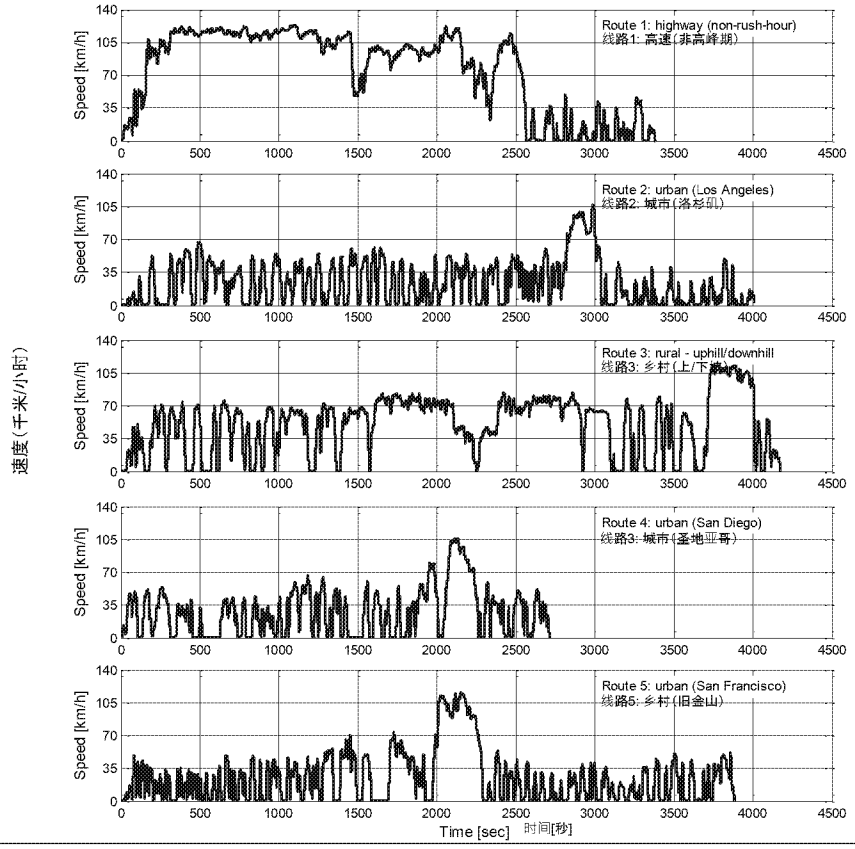
Route 4 – Urban (San Diego)
线路4 – 城市（圣地亚哥）

Route 5 – Urban (San Francisco)
线路5 – 城市（旧金山）

Route 3 - Suburban and Uphill/Downhill
线路 3 – 非城市地区及上下坡



Route description – Speed traces 线路描述 — 速度图谱

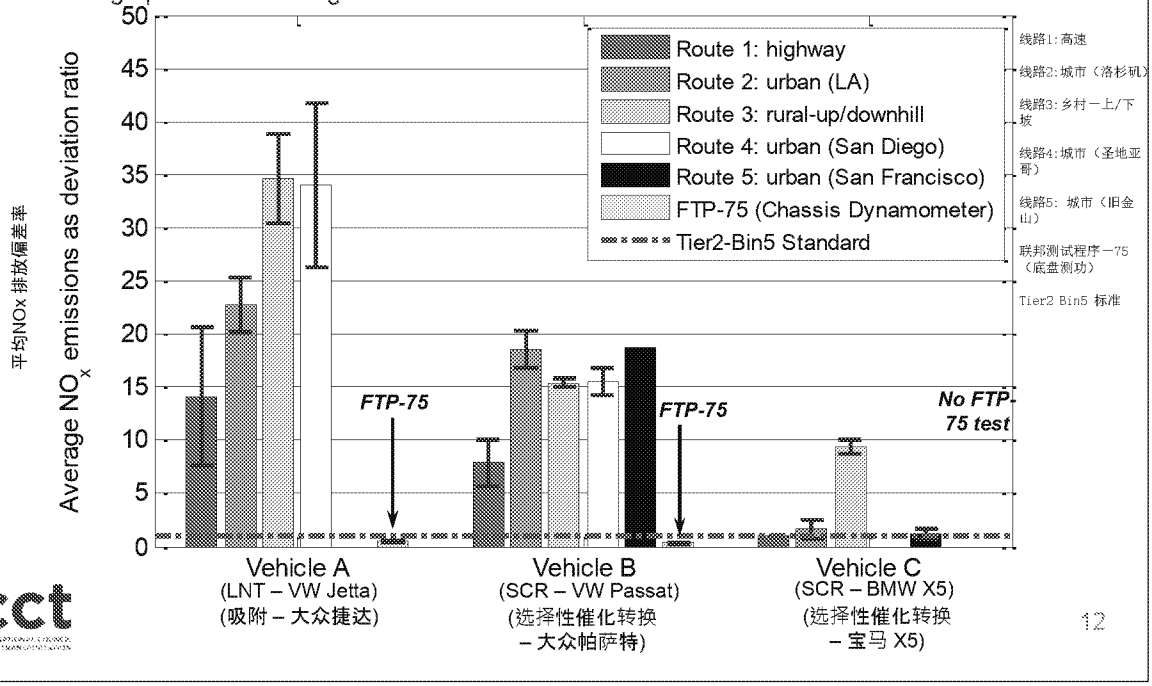


Route NOx emissions (total distance/total NOx)

线路NOx排放（总距离、总NOx）

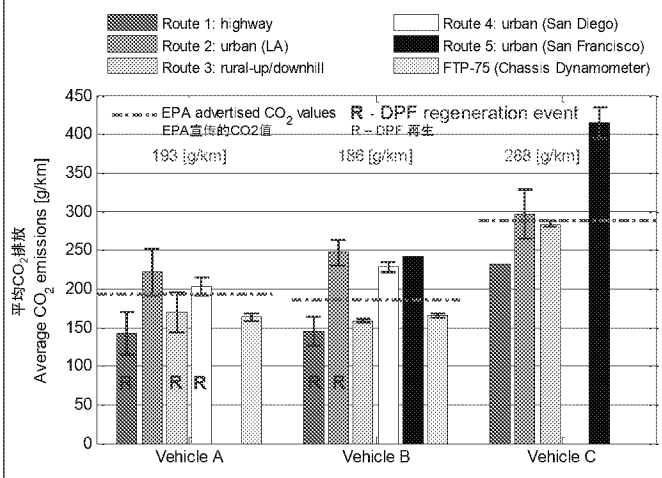
- Lowest NO_x during highway driving
- The BMW X5 had high NOx emissions only during up/downhill driving

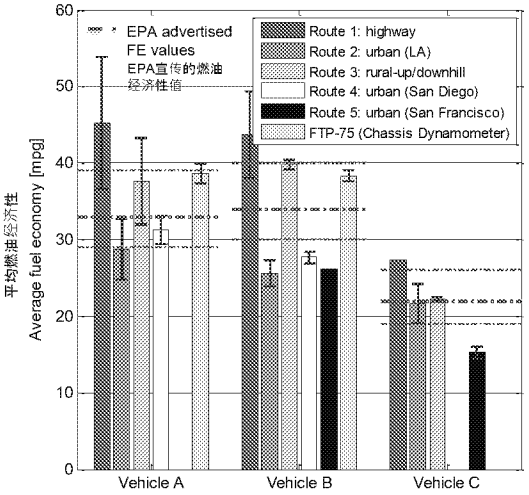
- 最低的 NO_x 发生在高速
- 宝马 X5 只在上/下坡有高NO_x排放



Results - Routes CO2 Emissions

结果 – 线路 CO2 排放





- Highway driving (i.e. Route 1) showed lowest CO_2 emissions / best fuel economy
- Urban/suburban driving showed highest CO_2 emissions / lowest fuel economy
- A 31% increase in CO_2 observed between non-rush-hour and rush-hour highway driving for *Vehicle A*
- Increased CO_2 emissions observed during DPF regeneration events for *Vehicles A* and *B*

- 高速行驶（如线路1）有最低的CO2排放/最好的燃油经济性
- 城市/郊区行驶有最高的CO2排放/最低的燃油经济性
- 车辆A在非高峰期和高峰期的高速行驶中显示出31%CO2的增长
- 车辆A和B在DPF再生时显示出升高的CO2排放

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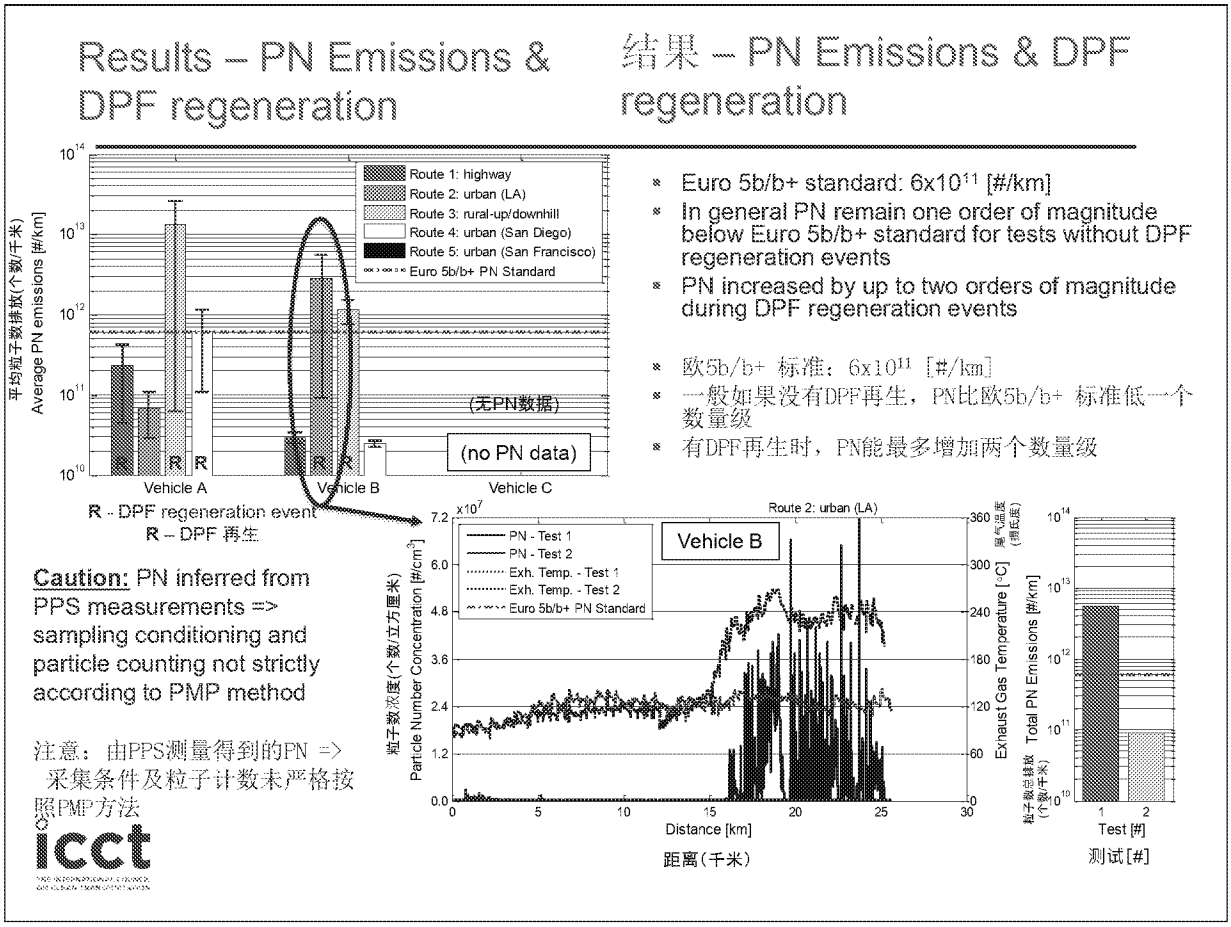
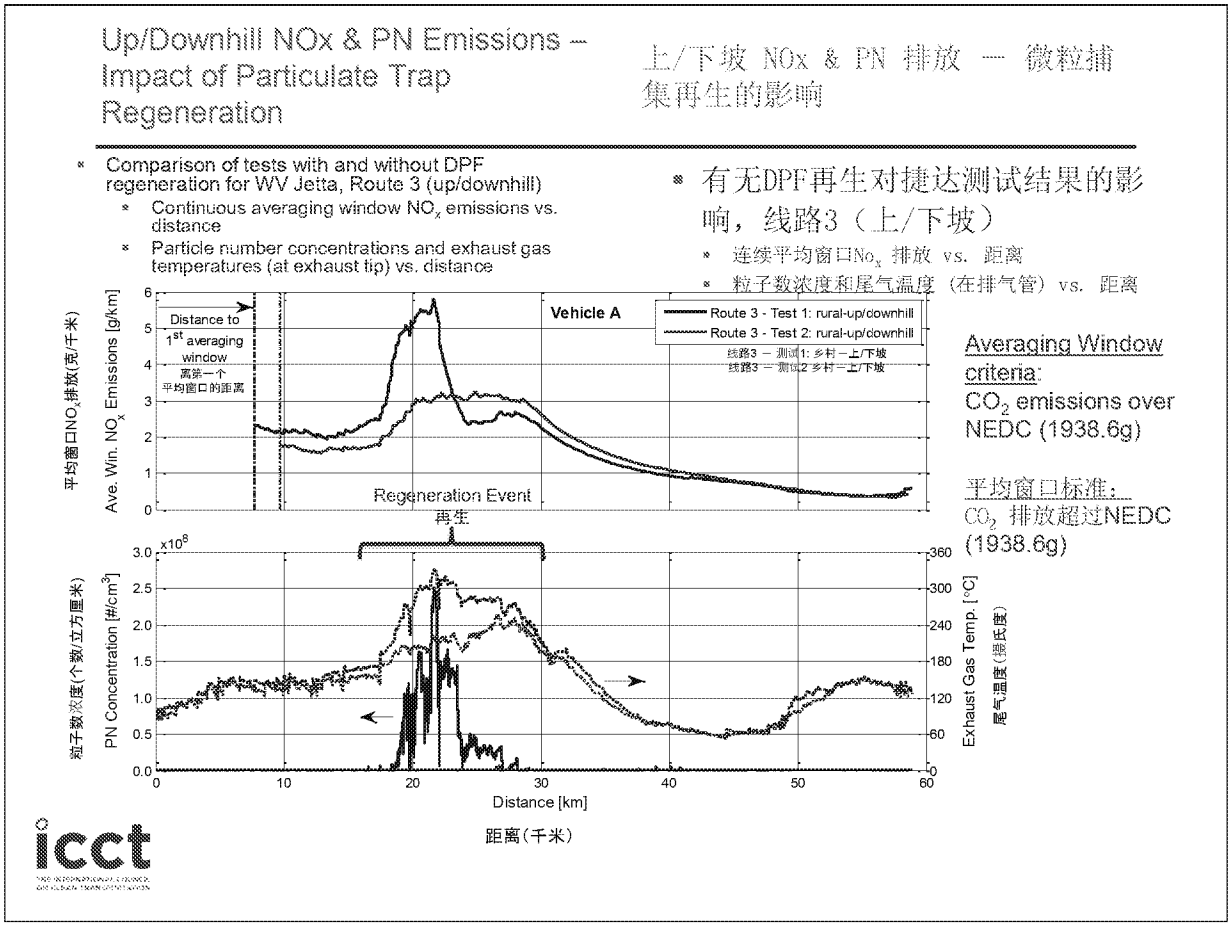
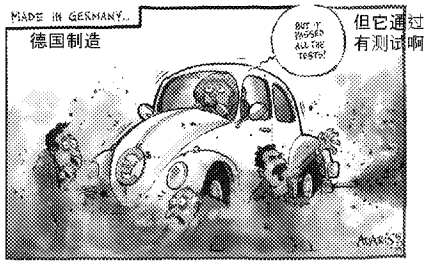


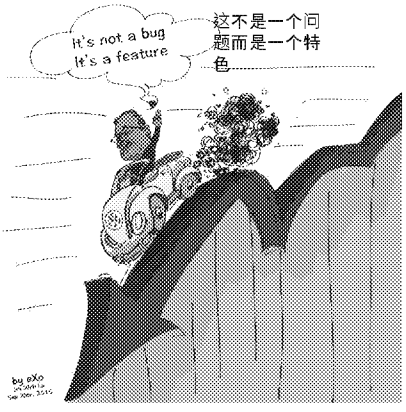
PN (particulate number) results are in upper left figure. The results are highly variable, influenced primarily by particulate filter regeneration events.
This is illustrated in the bottom middle figure. The upper lines on this figure are the exhaust gas temperature (right axis). This shows the expected increase in exhaust gas temperature increases during the regeneration event.
The bottom red line shows that PN emissions are low during normal operation. There is a huge increase in PN emissions during the regeneration event (blue line spikes).
In fact, as shown on the figure on the bottom right, average PN emissions over the entire trip increase by up to 2 orders of magnitude - without a DFP regeneration average trip PN is about an order of magnitude below the Euro5 PN standard, but average PN emissions over the entire trip if a DFP regeneration occurs are about an order of magnitude higher than the Euro5 PN standard.



This is similar to the previous slide, except it is for vehicle A (Jetta) and it also shows the impact of the DFP regeneration event on NOx emissions.
The top figure shows NOx emissions during two tests on the same route. The blue line shows that NOx emissions almost double during the DPF regeneration event.
The bottom figure is similar to that for vehicle B (Jetta) on the previous slide. Top lines are exhaust temperature, bottom red line shows low PN emissions when a DFP regeneration does not occur, and the blue spikes show the same massive increase in PN during the PDF regeneration.

Some illustrative cartoons　　最近的漫画对此事的说明





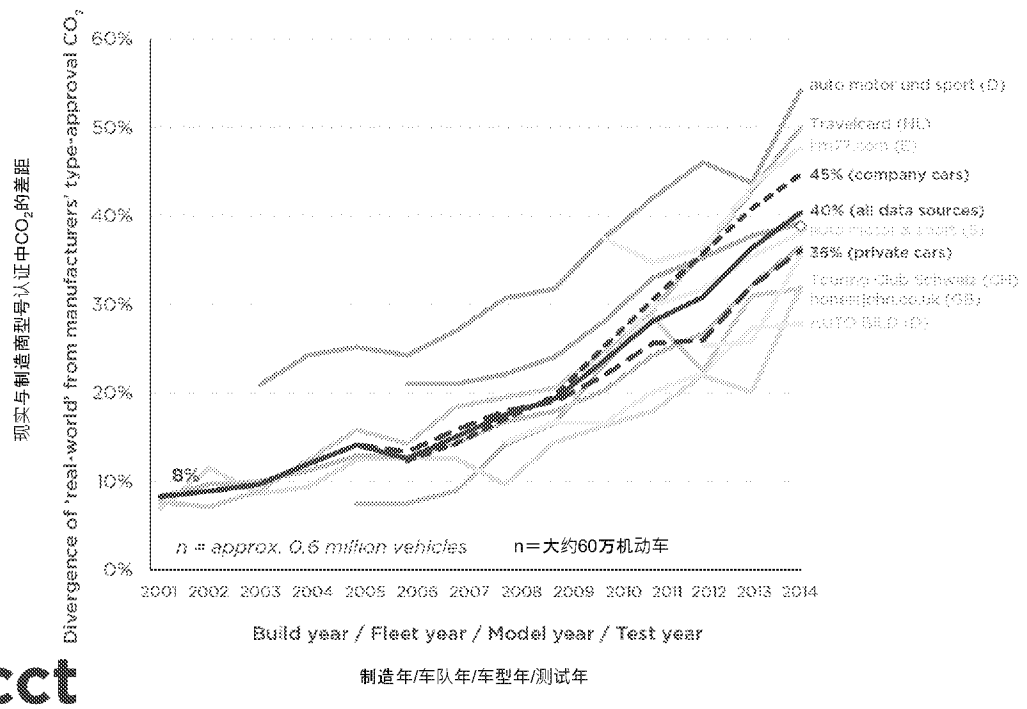
律师事务所

'We've found the problem. You're looking at £18billion plus parts and labour'

"我们找到了问题。你看到的是180亿加上零件和劳动力"

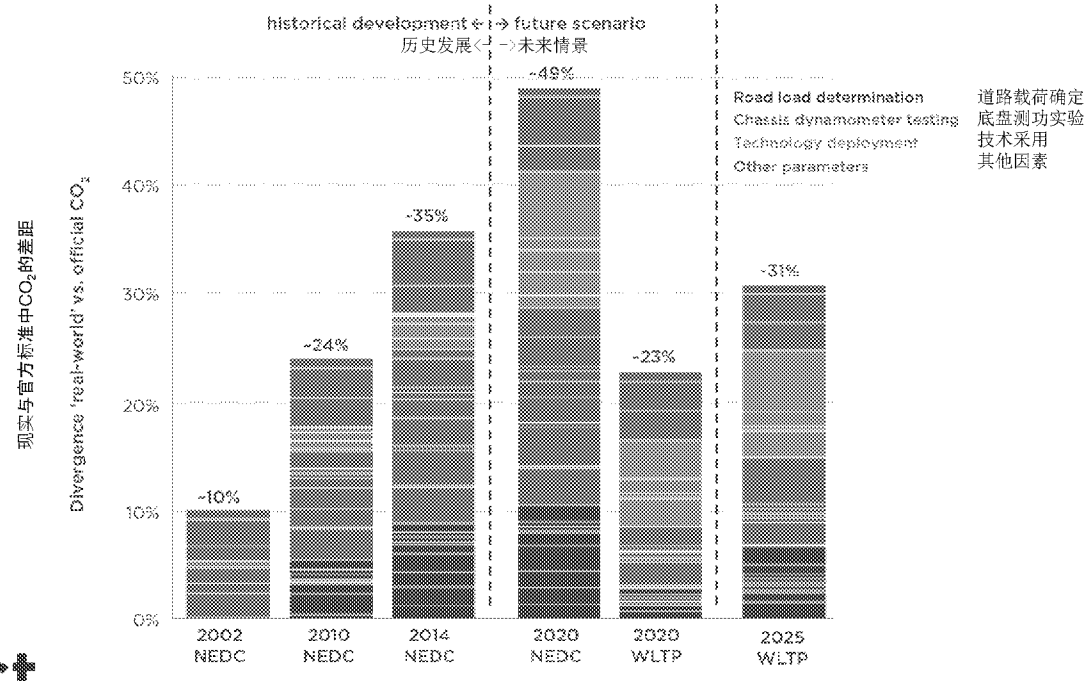
Real-world CO_2: the increasing gap

实际 CO_2 排放：日益扩大的差距



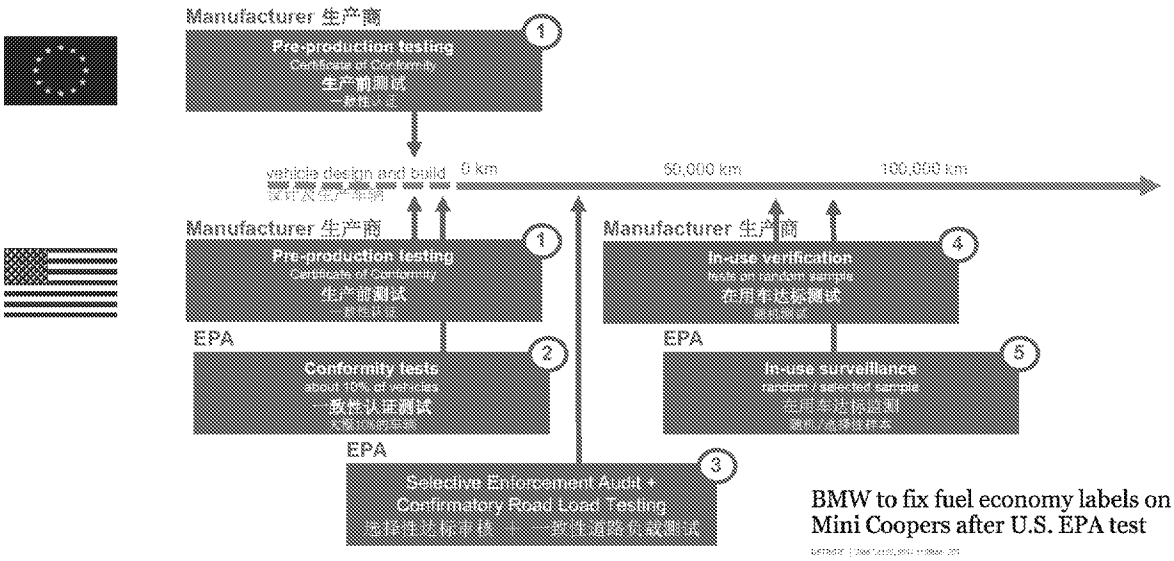
Real-world CO_2: reasons for the gap

实际CO_2排放：造成差距的原因



Regular government confirmatory testing is invaluable
Vehicle emissions certification/testing in the EU and US

在欧洲和美国，政府定期的验证测试是无价的汽车排放认证/检测



BMW to fix fuel economy labels on Mini Coopers after U.S. EPA test

U.S. Fines Hyundai, Kia for Fuel Claims

Penalty of $100 Million Is Largest Ever, Could Set Pricey Precedent for Other Auto Makers

宝马在EPA测试后修正Mini Cooper的燃油经济型标志

美国因燃油问题罚款现代，起亚

http://www.theicct.org/blogs/staff/tough-tiger-got-hello-kitty-how-fix-vehicle-fuel-economy-fraud-china

ICCT's position brief on reducing real-world driving emissions

ICCT 对于减少实际排放的建议

VW scandal is an opportunity to act fast, close the "real-world gap" using **readily available policy elements**:

- **Accelerated (2017) adoption of WLTP by NEDC regions:** Better cycle + robust procedure = more realistic results in the short term
- **Defeat device screening programs:** CARB and EPA's program a useful template for other world regions. EU member states urged to start screening immediately
- **In-use compliance programs:** Real world testing programs can be built on the basis of the European RDE experience, but using vehicles sourced from the real market (no more "golden cars"), and expanding the testing conditions to cover a wide range of operating conditions

- 大众事件是一个采取迅速行动，利用**现成政策要素**减少"现实差距"的机会：
- **加速（2017）NEDC地区采用WLTP的进程：更好的周期 + 可信的程序 = 短期内更多实际成果**
- **失效装置筛选：**CARB 和 EPA 的项目给世界其他地区提供了有用的模版。敦促欧盟成员国立即开始筛选。
- **在用车辆达标管理：**现实测试可以基于欧洲的RDE经验，但车辆需从市场获得（不再用"理想车辆"），并且扩大测试条件以涵盖不同的运行状况

List of publications 相关报告、资料列表

- Fact sheet: Light-duty diesel in-use tests: http://www.theicct.org/news/epas-notice-violation-clean-air-act-volkswagen-press-statement
- ICCT Report: Real-world exhaust emissions from modern diesel cars: http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars
- WVU Report: In-use emissions testing of light-duty diesel vehicles in the U.S.: http://www.theicct.org/use-emissions-testing-light-duty-diesel-vehicles-us
- U.S. EPA notice of violation: http://www3.epa.gov/otaq/cert/documents/vw-nov-caa-09-18-15.pdf
- ICCT Policy Briefing: Policy solutions to reduce vehicle exhaust emissions under real-world driving conditions: http://www.theicct.org/position-brief-oct2015-policy-solutions-real-world-emissions
- FAQ: In-use NOx emissions from diesel passenger cars: http://www.theicct.org/news/faq-use-nox-emissions-diesel-passenger-cars
- ICCT Report: NOx control technologies for Euro 6 diesel passenger cars: http://www.theicct.org/nox-control-technologies-euro-6-diesel-passenger-cars
- Real-world vehicle fuel economy gap continues to widen in Europe: http://www.theicct.org/news/real-world-vehicle-fuel-economy-gap-continues-widen-europe-press-release

Further questions? 其他问题请联系

- Drew Kodjak, Executive Director, (Washington DC), drew@theicct.org
- John German, US program co-lead (Ann Arbor), john@theicct.org
- Nic Lutsey, U.S. program co-lead (Washington DC), nic@theicct.org
- Anup Bandivadekar, passenger vehicles program lead (San Francisco), anup@theicct.org